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ARCHAEOLOGICAL EVIDENCE ON THE DIFFUSION AND EVOLUTION OF MAIZE IN NORTHEASTERN MEXICO

BY
PAUL C. MANGELSDORF, RICHARD S. MACNEISH* AND WALTON C. GALINAT

DESCRIPTION OF THE SITE

IN 1945 and 1946, one of the authors (MacNeish) conducted an archaeological reconnaissance for the University of Chicago in the state of Tamaulipas in northeastern Mexico. Analysis of the survey material revealed that one part of this region, the northern Sierra de Tamaulipas, contained a series of sites which might be expected to yield a stratigraphic sequence of cultures ranging from relatively simple manifestations lacking pottery, agriculture or large settlements to more complex stages including agriculture, large settlements and a well-advanced technology (MacNeish, 1947). It was hoped that data obtained from such a sequence might shed light upon the problem of the development of civilization in Meso-America or that it would, at least, illustrate the transition from a hunting, food-gathering existence to a sedentary, agricultural mode of life. Accordingly, in 1948 and 1949 an expedition under the auspices of the Viking Fund (now the Wenner-Gren Foundation for Anthropological

* National Museum of Canada.

Research, Inc.) excavated a series of sites in the northern Sierra de Tamaulipas, a number of which were in rock shelters along the Canyon Diablo (MacNeish, 1950).

The northern Sierra de Tamaulipas is about 20 to 60 miles west of the Gulf of Mexico and from 60 to 100 miles northwest of Tampico. The mountains themselves are an eastern spur of the Sierra Madre and are relatively steep, though they rise only to about 3000 feet above sea level. They are composed of Cretaceous limestone which was uplifted at the end of the Mesozoic era.

Subsequent cutting by erosion has produced a series of steep-sided canyons, all of which eventually drain into the Soto la Marina River, which flows to the Gulf of Mexico. The climate is, generally speaking, dry, with rainfall (580 to 800 mm. per year) occurring mainly in the summer. The vegetation of the area is largely xerophytic and includes mesquite (*Prosopis juliflora* DC.), epozote (*Chenopodium ambrosioides* L.), palmito (probably a species of palm), yucca (*Yucca* spp.), zacaton (*Muehlenbergia* spp.), otate (*Arundinaria* spp.), prickly pear (*Opuntia* spp.), pita (*Fourcroea* or *Agave* spp.), and tall grasses.

Excavations of eight stratified sites (five of which were caves or rock shelters), as well as excavations or surface collections of about a hundred single-period archaeological assemblages in 1946, 1949 and 1954, revealed a long sequence of cultures. These have been termed (from late to early) as follows: Los Angeles Phase, La Salta Phase, Eslabones Phase, Laguna Phase, La Perra Phase, Nogales Phase, Lerma Phase, Almagre Phase, and Diablo Complex (MacNeish, 1950). The delineation of this cultural sequence and its significance will be dealt with in another publication. However, one site, La Perra Cave (Tm c 174), not only yielded stratified remains of three of the above-cited archaeological phases (Laguna, La

Perra and Lerma), but it also contained sequential botanical remains, some of which are relevant to the problem of the early use and evolutionary development of maize. As an introduction to the study of the specimens of maize from this site, consideration of the location, geography, excavation, stratigraphy and cultural sequences of the La Perra Cave is here presented.

This rock shelter was discovered on a brief survey of the Canyon Diablo in March 1949, under the guidance of Pedro Lerma of Los Angeles, Tamaulipas. It is about 18 miles northeast of the town of Los Angeles, about one-quarter mile north of the point where La Perra Canyon enters the Canyon Diablo. The cave is on the steep west side of the valley. It is situated more than 150 feet above the arroyo bed in the middle of a vine and shrub-covered, 100-foot-high cliff, at a point about 60 feet above the base. At the foot of the cliff is a talus slope covered with dense vegetation. The cave is not readily accessible, but can be approached by ascending a stream bed 400 feet north of it until a ledge at the level of the cave is reached. From here, one proceeds, preferably on hands and knees, southward along this ledge to the shelter. It is also possible to come down to the cavern from the plateau above, but, unfortunately, this approach was not discovered until after the excavations were completed.

The cave itself is situated in thinly-bedded Cretaceous limestone. It is about 23 feet deep, 40 feet wide at the mouth, 48 feet wide at 15 feet back from the mouth, and reaches a maximum height of about 15 feet. The floor of the cave slopes gently downward from the back wall to about eight feet from the mouth, where it dips very sharply.

No water is at present available during the dry season for a distance of 15 miles from the cave, but during prehistoric times there may have been water seepage from

the lower cliff wall or in the canyon itself. During a more humid period, the plateau above the cave or the low, wide terrace lying to the east across the Canyon Diablo bed may have been amenable to agriculture.

A test excavation made in Tm c 174 in February 1949, showed distinct zones and a few artifacts. A later test excavation turned up very few additional artifacts and the site was about to be abandoned when three maize cobs wrapped in maguey string, and a fragment of *petate* (woven fiber mat) were found. After this discovery, the entire cave was excavated, following the conventional method of digging in five-foot squares.

The stratigraphy of the cave comprised five zones. The uppermost, zone A, was made up of loose rock fill underlaid by ash and a layer of refuse composed in part of well-mixed vegetal material. The zone varied in thickness from four to 14 inches in different parts of the cave.

Underlying zone A was a stratum composed of gray refuse and lenses of ash and vegetal material separated from each other by soil. This was called zone B. It varied in depth in different parts of the cave and appeared to comprise several different levels of occupation. In analyzing the vegetal remains, a distinction was made between High B and Low B.

Zone C was a sterile layer composed of small flakes of rock and fine silt formed by the weathering of the surrounding limestone under relatively dry climatic conditions.

Zone D was a dark gray, almost black, cultural stratum, interspersed with layers of rock, covering only part of the cave floor and usually about a foot thick. Occasionally under zone D there was a thin layer of yellow silt, devoid of human remains, which is called zone E. In most of the cave, zone D lay directly on the limestone floor.

The earliest cultural remains come from zone D and are considered to belong to the Lerma Phase. At present, these cannot be accurately dated. The presence of thin fragments of deer bones, numerous large, double-pointed, thick projectile points and a wide variety of skin-scraping, chopping and cutting tools suggest that the subsistence of the first occupants of La Perra Cave was based largely on hunting.

The second complex of artifacts, from zone B, are considered to belong to the La Perra Phase. Other components of this phase were exhumed in Nogales Cave, 12 miles down the canyon from La Perra Cave, and in Cueva Humada in the southern Sierra de Tamaulipas. Altogether five sites belonging to this phase were found during the reconnaissance. The La Perra Phase appears to be related to a series of archaeological manifestations which range spatially from southern Texas to San Luis Potosi, Mexico. One of these from Falcon Dam in Texas, has been dated as 4650 years old, another from Tamaulipas as 3945 years old.

Vegetal remains from the lower part of zone B have been dated by radiocarbon determination at 4445 ± 180 years ago (Libby 1952).

An abundance of preserved remains (2504 specimens) of food plants, of which only a small number represent cultivated species, and the presence of stone mortars in zone B, suggest the extensive gathering of wild food plants. Fragments of animal bones, as well as projectile points and yucca fibers tied to form slip loops, indicate some dependence on the hunting and snaring of animals. A few specimens of squash (*Cucurbita Pepo*) and of maize cobs and husks suggest an incipient agriculture.

The final occupation of the cave, represented by zone A, is poor in artifacts. However, the presence of sherds, a figurine, point fragments and ovoid blades, showed the

occupation to be a component of the Laguna Phase which is well represented in the hill-top ruins that occur throughout the Sierra de Tamaulipas. This phase has definite affinities with the El Prisco (II) period of the Tampico-Panuco region (the Huasteca), which in turn has been correlated by Ekholm (1944) with the Ticoman-Cuilcuilco horizon of the valley of Mexico and which is dated by radiocarbon determinations at about 2400 years ago (de Terra, 1951). Allowing for some lag in the Sierra de Tamaulipas, a date of 1800 to 2200 years ago for the Laguna Phase would seem to be a fair estimate.

The foodstuffs in zone A of La Perra Cave indicate that the Laguna people were primarily agriculturists, growing beans, manihot, cotton, gourds, squashes, and maize. The abundance of angle-backed *metates* and roller *manos* in the hill-top ruins tend to confirm this. Wild food plants were, however, still gathered — 1426 specimens were found. Stemmed, corner-notched and side-notched points, as well as 122 animal bones in zone A, show that hunting was still practiced.

In summary, the sequence represented by the archaeological remains, seems to comprise three cultures, the first a predominantly nomadic hunting culture with no agriculture; the second a semi-sedentary hunting and food-gathering culture practicing an incipient agriculture; and the third a sedentary food-growing culture with a relatively advanced technology. The remains of maize found in the cave are confined to the last two cultures.

Description of the Maize

The archaeological specimens of maize from La Perra Cave are of particular interest from four standpoints: 1. The oldest specimens may be quite old, *ca* 4450 years; 2. The earliest maize is associated with incipient agriculture and may represent a maize in the early stages

of domestication; 3. The specimens represent a well-defined evolutionary series in a race of maize which still exists in Mexico; 4. The earliest maize definitely has its affinities in the south and is of Mayan origin.

The specimens comprise 177 items, including 87 cobs and fragments of cobs large enough for detailed study; 31 small fragments of cobs; 56 husks; and three quids which appear to be chewed maize husks.

Classification of the Cobs

As a whole, the cobs represent the most uniform lot of prehistoric maize which we have studied. Of the 87 cobs, 78 can be said, without much question, to belong to a single race which is clearly related to the living Mexican race, Nal-Tel. This race has been described by Wellhausen *et al* (1952), who report that it is grown in a number of localities in the states of Yucatan and Campeche and, sporadically, in Guerrero, Oaxaca, and San Luis Potosi. Nal-Tel is regarded by these authors as one of the four ancient indigenous races of Mexico and, therefore, as relatively primitive when compared to other races of modern maize. Nal-Tel is believed to have been widely distributed in ancient times. It is one of the putative parents of a number of modern Mexican races of maize, including Zapalote Chico, Zapalote Grande, Bolita, and Vandeño. Ears of it are depicted on a specimen of pottery from Guatemala and on Zapotec funerary urns (Plates XXXV and XXXVI).

Nal-Tel is described by Wellhausen *et al* as a race of short, early-maturing plants almost lacking in pubescence. The ears are small, short, and taper slightly at both ends. The number of kernel rows is usually ten or twelve. The kernels are small, broader than long, rounded and flinty. The rachis is slender and the glumes are relatively long and prominent. The shank, or peduncle, on

which the ear is borne is slender. The rachis flap, which represents a lateral wing of the cupule, is prominent.

Late Nal-Tel: Of the 78 cobs recognized as belonging to the race Nal-Tel, only 18 are counterparts of the modern Nal-Tel of the Yucatan peninsula. These are designated as Late Nal-Tel. The cobs have the same shape and approximately the same size as cobs of the living race. A comparison of the two is made below:

Characteristics	*Modern*	*Archaeological*
Ear length (mm.)	79.0	85.5
Cob diameter (mm.)	19.2	21.2
Rachis diameter (mm.)	9.2	11.4
Row no.	10–12	10–12

Typical cobs of Late Nal-Tel are illustrated in Plate XXXII.

Early Nal-Tel: The remaining 60 cobs resembling Nal-Tel represent a more primitive form of this race. The cobs are shorter and more slender. The rachises are smaller in diameter and, perhaps as a consequence, the ears have a lower row number. The glumes are fleshy and, although not actually longer than those of Late Nal-Tel, are more prominent in relation to the slender rachis.

The Early Nal-Tel cobs were further divided into two types, A and B, the former being smaller and more slender than the latter. These differences may be due in part to environmental effects. However, since a separation has been made for purposes of study, the data on the two types are presented separately. Cobs of the two types are illustrated in Plates XXX and XXXI.

Dzit-Bacal: Six cobs in the collection are definitely of a distinct type which differs from Nal-Tel. These are long, straight and slender, with especially slender ra-

chises. The glumes are slightly indurated. These cobs appear to be related to a race, Dzit-Bacal, described by Wellhausen *et al*, which now occurs most commonly in Yucatan and Campeche, where it hybridizes freely with Nal-Tel.

Breve de Padilla: The remaining three cobs, all large, cannot be definitely assigned to any race described by Wellhausen *et al.* They seem, however, to be related to a modern race, recently found in Mexico, in the state of Tamaulipas, known as Breve de Padilla (Wellhausen, unpublished). Since the sample comprises only three cobs, this identification cannot be considered as final.

Relation of Cob Types to Archaeological Zones

The above classification, which is based upon both external and internal characteristics of the cobs, was made without any knowledge of the relative age of the specimens. When the cobs are also classified with respect to the archaeological zone in which they occurred, it is apparent that there is a correlation between type and zone (Table I). Cobs of Breve de Padilla and Dzit-Bacal occurred only in zone A, cobs resembling modern Nal-Tel only in zones A and AB (the latter probably a mixture of zones rather than a distinct entity). Cobs of both types of Early Nal-Tel were found in both zones and were the only type occurring in zone B.

There seems to be little doubt that agriculture in this locality began with an early type of Nal-Tel and that the occupation of the cave ended shortly after the introduction of Dzit-Bacal from the south. Whether the Late Nal-Tel found in zone A was also introduced from the south or is the product of the local hybridization of Early Nal-Tel and Dzit-Bacal, it is not possible to determine. It does seem reasonably certain, however, that there was

little change in Early Nal-Tel itself during the period represented by these remains. There is no significant change from zone to zone, either in the frequency of types A and B of Early Nal-Tel or in their characteristics. Certainly there is no evidence that this race was improved by selection, either natural or artificial, during

TABLE I. Classification of specimens of La Perra maize.

Specimens	Zone				
Cobs, Race or Type	A	AB	High B	Low B	Totals
Breve de Padilla	3				3
Dzit-Bacal	6				6
Late Nal-Tel	14	4			18
Early Nal-Tel Type B	17	6	2	11	36
Early Nal-Tel Type A	19	3	1	1	24
Total cobs	59	13	3	12	87
Fragments of cobs	24	5	2		31
Husks	22	31	3		56
Quids	2			1	3
Total maize specimens	107	49	8	13	177 *

* There are, in addition, three cobs loaned to the Museum of Anthropology, University of Michigan, which were not analyzed.

this period. Improvement did not come about until something new was introduced, from the south, or hybridization occurred in the area.

Late Nal-Tel, which first appears in zone AB, but which, since zone AB probably represents a mixture, may actually be confined to zone A, is definitely a different type of maize than Early Nal-Tel, as the data in Tables II and III show.

One of the important differences between these two types is in teosinte introgression. This almost invariably affects the texture of the lower glumes, causing them to become lignified and indurated. In Early Nal-Tel, of

TABLE II. Characteristics of the cobs of the races of La Perra maize.

	Zone				
Length Intact Cobs (mm.)	A	AB	High B	Low B	Averages
Breve de Padilla	134				134
Dzit-Bacal	117				117
Late Nal-Tel	85	88			86
Early Nal-Tel Type B	62	57		52	60
Early Nal-Tel Type A	48	49	44		48
Averages	66	65	44	52	
Diameter Cob (mm.)					
Breve de Padilla	26.0				26.0
Dzit-Bacal	19.7				19.7
Late Nal-Tel	21.4	21.7			21.5
Early Nal-Tel Type B	18.1	18.3	17.6	19.0	18.4
Early Nal-Tel Type A	15.2	16.0	10.0	18.4	15.2
Averages	18.4	18.9	15.0	19.0	
Diameter Rachis (mm.)					
Breve de Padilla	16.3				16.3
Dzit-Bacal	11.1				11.1
Late Nal-Tel	13.2	12.7			13.1
Early Nal-Tel Type B	10.4	10.2	10.1	11.3	10.7
Early Nal-Tel Type A	8.4	8.5	6.5	8.3	8.3
Averages	10.8	10.6	8.9	11.1	
Cob/Rachis Index					
Breve de Padilla	1.59				1.59
Dzit-Bacal	1.78				1.78
Late Nal-Tel	1.62	1.72			1.64
Early Nal-Tel Type B	1.75	1.81	1.74	1.73	1.75
Early Nal Tel Type A	1.89	1.88	1.54	2.22	1.89
Averages	1.76	1.80	1.68	1.77	
No. Rows Grain					
Breve de Padilla	12.0				12.0
Dzit-Bacal	9.3				9.3
Late Nal-Tel	10.9	11.0			10.9
Early Nal-Tel Type B	10.0	10.0	10.0	10.5	10.2
Early Nal-Tel Type A	8.8	8.7	10.0	10.0	8.9
Averages	9.9	10.0	10.0	10.5	

59 cobs scored, only seven appeared to have indurated glumes; and all of these, on further study, proved to be slightly charred, and, as a consequence, hardened. Of 17 cobs of Late Nal-Tel, nine had distinctly lignified glumes.

Another characteristic of teosinte-contaminated maize is the manner in which the floral structures separate from the rachis. In pod corn and in races of "pure" maize, the breakage occurs below the lower glume, leaving the rachis completely exposed. In maize strongly contaminated with teosinte, the lower glumes are, as in teosinte itself, indurated like the rachis and tend to remain firmly attached to it, while the upper glume with the lemmas and paleas are easily separated from the cob. Such cobs, which have lost the upper glumes, lemmas and paleas, but have retained the indurated lower glumes, have the appearance of coarse rasps with stiff teeth projecting from the surface approximately at right angles.

Most of the ears of Late Nal-Tel, as well as those of Dzit-Bacal, show to a discernible degree this type of disarticulation, which is characteristic of teosinte-contaminated maize. The majority of the cobs of Early Nal-Tel show the disarticulation characteristic of "pure" maize.

It is not possible, from the limited number of cobs available, to draw final and complete conclusions regarding the sequence of maize types grown by the La Perra cultivators. The data, so far as they go, are consistent with the hypothesis that the early tenants of the cave grew only one race of maize, Early Nal-Tel, a "pure" maize, uncontaminated by teosinte, and which had its origin in the south. Later occupants of the cave grew three new types, Late Nal-Tel, Dzit-Bacal, and Breve de Padilla, two of which have affinities with the maize of the Maya region and also show evidence of teosinte introgression.

The data are also consistent with those from other

TABLE III. Internal characteristics of the cobs of the races of La Perra maize.

	Zone								Totals	
Lower Glumes: Fleshy vs Horny	A		AB		High B		Low B			
Breve de Padilla	1	2							1	2
Dzit-Bacal	1	5							1	5
Late Nal-Tel	4	9	4	0					8	9
Early Nal-Tel Type B	11	5	5	1	2	0	10	1	28	7
Early Nal Tel Type A	19	0	3	0	1	0	1	0	24	0
Totals	36	21	12	1	3	0	11	1	62	23
Upper Glumes: Glabrous vs Hairy										
Breve de Padilla	3	0							3	0
Dzit-Bacal	4	2							4	2
Late Nal-Tel	4	9	3	1					7	10
Early Nal-Tel Type B	12	4	5	1	2	0	10	1	29	6
Early Nal-Tel Type A	15	4	3	0	1	0	1	0	20	4
Totals	38	19	11	2	3	0	11	1	63	22
Disarticulation of Glumes: Maize type vs Tripsacoid										
Breve de Padilla	1	2							1	2
Dzit-Bacal	1	5							1	5
Late Nal-Tel	1	12	3	1					4	13
Early Nal-Tel Type B	10	6	5	1	2	0	10	1	27	8
Early Nal-Tel Type A	17	2	3	0	1	0	0	1	21	3
Totals	30	27	11	2	3	0	10	2	54	31
Rachis Flap: Weak vs Prominent										
Breve de Padilla	2	1							2	1
Dzit-Bacal	0	6							0	6
Late Nal-Tel	2	11	1	3					3	14
Early Nal-Tel Type B	6	10	2	4	1	1	3	8	12	23
Early Nal-Tel Type A	4	15	2	1	0	1	1	0	7	17
Totals	14	43	5	8	1	2	4	8	24	61

sites. Galinat *et al* (1956) found definite evidence of teosinte introgression in the archaeological maize at Richards' Caves and Tonto Cave in Arizona. Their review of the literature showed that Tripsacoid cobs also occurred in Bat Cave and Tularosa Cave in New Mexico and in the Hueco Mountain Caves of western Texas. Preliminary studies of archaeological material collected by Robert Lister from several caves in Chihuahua in northwestern Mexico indicate that teosinte introgression has occurred in that region also.

Since teosinte is not known to occur in Tamaulipas at the present time, there is a question regarding the origin of the teosinte introgression in Late Nal-Tel and Dzit-Bacal of La Perra Cave. It is probable that this occurred in southern Mexico. Wellhausen *et al* regard Dzit-Bacal as a subrace of Olotillo, which is highly Tripsacoid and they report that modern Nal-Tel is slightly Tripsacoid, presumably as a consequence of hybridization with Dzit-Bacal.

An Extreme Form of Early Nal-Tel

As important as the range of variation in these specimens, or the average value for any one characteristic, are the exceptional cobs. One of these in particular, cob 127D5, is somewhat different from any maize cob which we have previously examined. It is eight-rowed and has a very slender rachis which is approximately square in cross section. The cupules are compressed, deep, and are lined with a profuse covering of stiff hairs. The glumes are long, fleshy, and completely glabrous. They have the aspect of normal glumes of a wild grass. It is not likely that they completely enclosed the kernels, but they may have surrounded all parts of the kernels except the upper surfaces. The cupules, which in ordinary maize are tightly compressed on the rachis, with their lateral wings

called "rachis flaps," sometimes protruding from the surface, are in this specimen loosely spaced with the result that the rachis flap is extremely prominent. The phytomers of the rachis are loosely joined. The general structure is one which, if its characteristics were slightly exaggerated, would furnish a mechanism for the breakage of the ear and the dispersal of the seeds. The structure of this cob and its parts is shown in Plate XXXIV.

This is the first archaeological maize approaching a type capable of self-sowing which we have encountered. Although there is little possibility that it is wild maize, it may not be too far removed from it. And yet it has no characteristics in which it differs completely from the remaining specimens in this collection. It merely exhibits the characteristics of Early Nal-Tel in somewhat accentuated form.

Is Early Nal-Tel a Pod Corn?

Mangelsdorf and Reeves (1939), following earlier students of maize, postulated that primitive maize was both a pop corn and a pod corn. The cobs of Early Nal-Tel bear out the first assumption. Whether they support the second may be largely a matter of definition. Certainly the primitive Nal-Tel with its relatively thick, fleshy glumes is different from any tunicate maize of this type known today. Mangelsdorf (1948) has shown, however, that there are several intermediate alleles at the *Tu-tu* locus on chromosome 4 and it may well be that Nal-Tel carries one of these. Unfortunately, it is impossible to test the genotype of Early Nal-Tel to determine which of the alleles at the *Tu-tu* locus is responsible for its prominent glumes. However, another Mexican pop corn, Chapalote, closely related to Nal-Tel, has relatively prominent glumes similar to those of Nal-Tel and genetic tests indicate that these are governed by an intermediate

allele in this series. Crosses of Chapalote with sugary endosperm, *su*, on the fourth chromosome, show linkage between *Su* and prominent glumes (Mangelsdorf, 1953). The resemblance of Nal-Tel and Chapalote, considered with the evidence on linkage of long glumes and starchy endosperm in Chapalote, would suggest that the prominent glumes of Nal-Tel involve one of the intermediate alleles in the *Tu-tu* series.

The Husks

The collection contained 56 well-preserved specimens of husks, some representing only a single sheath, others the entire husk covering still attached to the shank.

Flag Leaves and Ligules: Husks, which in modern maize surround and usually tightly enclose the ear, are modified leaf sheaths, sometimes with reduced blades, called "flag leaves," attached and a recognizable ligule at the point of attachment. Of nine completely intact husks in this collection, not one had either a "flag leaf" or a ligule.

Relative Length: The husks are rather uniform in length. Twenty-one specimens are intact, or almost so, with respect to length, and these are much longer than the cobs occurring in the same zones. The length of intact husks and cobs is compared in Table IV. The husks, which average 140 mm. in length, are 2.3 times as long as the corresponding cobs which average 60 mm. In making these comparisons, only cobs of Early and modern Nal-Tel and only husks with definite parallel venation have been included. Specimens from zone B indicate that these types of ears and husks are associated.

Mangelsdorf and Smith (1949), studying archaeological remains of husks from Bat Cave, concluded that the

husks were considerably longer than the ears which they subtended and that, instead of tightly enclosing the ears, they constituted an open involucre at the base of the ear. The La Perra specimens tend to support and to amplify these conclusions.

A single specimen of a young ear shoot, partly chewed, shows clearly that at the time of emergence of the silks the pistillate spike is tightly enclosed in the husks.

TABLE IV. Length of intact shucks of La Perra maize compared with length of intact cobs of Early and Late Nal-Tel.

Specimens	Zone			Total or Average
	A	AB	B	
No. shucks	4	15	2	21
Length (mm.)	135	142	135	140
No. cobs	21	3	2	26
Length (mm.)	61	68	48	60

Therefore, if the husks open to form an involucre, this must take place later as the pistillate spike matures. In a recent trip to Mexico, the senior author made a special effort to determine whether the flaring open of the husks at maturity is a characteristic of modern Nal-Tel and he discovered that many of the plants of this race do have this feature. It may well be, therefore, that the spreading of husks at maturity is a primitive characteristic which, in wild corn, was an important step in the mechanism of seed dispersal.

Venation: The husks are also quite uniform with respect to their venation. With few exceptions, all of them have distinct parallel venation. In modern maize, where the husks are often stretched tightly around the mature ear, the aspect of parallel venation is partly lost as the anastamosing venation between the principal veins be-

comes more prominent. In more primitive maize, parallel venation is distinct, even in the inner husks, and causes striations on the surface of the kernels (Mangelsdorf and Smith, 1949).

Pubescence: To the naked eye, and to the touch, all but three of these specimens are glabrous, the three exceptions being slightly hispidulous. When examined under the microscope, however, all of the husks proved to have very short hairs, either on the inner or outer surface, or both. Not one was completely lacking in hairs. There is no evidence that variation in this feature is associated with archaeological zones.

The fact that the husks, which are modified leaf sheaths, and the glumes, which are modified leaves, are predominantly glabrous (macroscopically) might indicate that the plants on which these specimens were borne were also glabrous. Wellhausen *et al* report that plants of modern Nal-Tel have little pubescence.

The Shanks

The cobs themselves with their slender rachises would indicate that the ears of La Perra maize were borne on slender shanks or peduncles. Husks with shanks still attached bear out this indication. Twelve specimens have an average diameter of 6.7 mm. at the point at which the ear was removed. This compares with a shank diameter of 7.1 mm. for modern Nal-Tel reported by Wellhausen *et al.*

These same specimens are useful in showing how the husks are spaced on the shank. Each husk arises from a node on the shank which is itself a branch of the main stalk. In many modern varieties of maize, the internodes on the shank are long, and the entire husk-bearing space, which is essentially equivalent to the length of the shank,

may in some cases be as long or longer than the ear itself. In the La Perra maize, the internodes of the shank are extremely short and the entire shank is correspondingly so. In the twelve specimens mentioned above, the length of the shank varies from 6.0 mm. to 33.0 mm. and the average is 8.6 mm.

Among modern varieties of maize, ears with short, slender shanks are usually borne at a high position on the culm. On any given plant, there is usually a strong inverse correlation between the relative height of ear and length of shank. Galinat (1954) found that the shank lengths for twelve ears borne on a single stalk of Argentine pop corn varied from 19 mm. in the uppermost ear to 134 mm. in the lowermost. The short shanks of the La Perra maize, therefore, might suggest that the ears of this maize were borne high on the stalk. The data of Wellhausen *et al*, as well as the internode patterns illustrated in their Plate VIII, tend to support this suggestion. They show that plants of modern Nal-Tel have, on the average, 4.3 leaves above the ear and that the internodes above the ear are relatively short. This is also true of some modern pop corn varieties, and it may suggest that a high position of the ear on the culm is a primitive character. If so, the early maize of La Perra Cave may have had this character, as it clearly had others, in accentuated form. Indeed, it is possible that primitive maize may have borne its ear immediately below the tassel (Galinat, 1954). In some of our cultures of tunicate and half-tunicate maize, we have encountered a number of plants in which small ears were borne at the first node below the tassel. The husks on such ears are few in number and lack flag leaves and ligules, although ears borne lower on the same stalks may have prominent flag leaves and conspicuous ligules. These sub-tassel ears are enclosed by the husks at pollinating time and for several weeks

thereafter; but eventually they spread open, exposing the ear.

Primitive Nal-Tel Reconstructed

In those characteristics which can be studied in archaeological remains, Early Nal-Tel proves to be modern Nal-Tel with some of its characteristics in accentuated form. If it may be assumed that this is also true for other features, it is possible by extrapolation to reconstruct this precursor of the modern, though still somewhat primitive race.

So far as the characteristics of the ear are concerned, little extrapolation is needed. Primitive Nal-Tel ears were short, rather stubby, eight-rowed, with small, short, broad, flinty kernels. Such ears are beautifully depicted in one of the funerary urns from Oaxaca described and illustrated by Caso and Bernal, 1952, which is reproduced by permission of the authors in Plate XXXVI. Unfortunately, the exact dimensions of the urn are not available. However, if it has approximately the same dimensions as other urns of this type, the ears represented on it are about 47 mm. long. This figure corresponds closely to the average length, 48 mm., of cobs of Early Nal-Tel, Type A.

The ears were surrounded, but at maturity apparently not completely enclosed, by husks. The short, slender shanks indicate that the ears were borne at one of the higher nodes.

For other characteristics, we turn to the data of Wellhausen *et al* (Tables 13–17) which show that the plants of modern Nal-Tel are the shortest of any living race in Mexico (averaging four feet) and bear the fewest leaves (averaging twelve). The leaves are among the shortest and, in proportion to length, the broadest. The internodes above the ear are shorter and fewer than those of

any other race. The shank is short and slender. The condensation index, 1.0, is the lowest of any Mexican race. Nal-Tel is early in maturity, highly susceptible to rust, low in pilosity and has a light sheath color.

When we reconstruct a primitive Nal-Tel in which a number of these features occur in accentuated form, we find that a plant resembling it has already been depicted for us in one of the ancient Mexican codices (see Wellhausen *et al*, 1952, Fig. 3). Botanists who are familiar with this illustration have always regarded it as highly stylized. In the light of the characteristics of Nal-Tel, there is reason to suspect that the maize plant depicted is not completely stylized, but that it is accurate in illustrating a maize with short stalks, relatively few short, wide leaves, and bearing at one of the upper nodes a short ear incompletely enclosed in husks.

Although Early Nal-Tel differs from modern Nal-Tel in a number of characteristics, the differences are not great and are more a matter of degree than of kind. There has actually been very little evolution in this race of maize in a period of some 4500 years. This is in marked contrast to certain other Mexican races in which evolution has been rapid and even spectacular.

Primitive Uses of Maize

How did the primitive La Perra farmers use maize? It is reasonable to suppose that, just as there has been evolution in the maize plant, so has there also been evolution in methods of utilizing it. It may also be supposed that this evolution has been from the more simple to the more complex. The archaeological remains suggest several uses.

Chewing Young Ears: The simplest and easiest method was to chew the young ears, husks and all, soon after

pollination. There are, among the specimens, two thoroughly chewed quids which do not seem to be quids of yucca or maguey, and whose fibers are similar to those of maize husks. In addition, there is one specimen, an unpollinated or recently pollinated ear, enclosed in husks, in which chewing was begun but not completed.

There is no doubt that the young maize ear is an attractive food morsel. After seeing these prehistoric quids, we tried chewing young ears enclosed in husks and found them tender, succulent and sweet. No equipment of any kind is required in consuming maize in this way. The method is, of course, quite wasteful from the standpoint of efficient utilization of the maize plant and, if universally practiced, would lead to the plant's extinction; but it is a quick and simple way of obtaining a little sugar.

Green Corn: A second use of primitive maize is as green corn. There are several specimens in which the lower part of the kernel still remains within the glumes, the upper part having been removed, either by chewing or with a coarse blade. Roasted ears of green corn, *elotes*, are still a popular delicacy in Mexico, as apparently they were in prehistoric times.

Popped or Parched Corn: Other common uses of maize are by popping or parching. We have found no actual remains of popped maize among the specimens from La Perra Cave, but many of the cobs are slightly scorched or charred, showing that they have been exposed to heat. To pop maize, the only equipment needed is a bed of hot coals and a green stick sharply pointed at one end and pushed into the base of the ear. The ear is held over the coals and slowly rotated. We have simulated this procedure with modern pop corn, substituting an electric hot plate for glowing coals. The kernels explode while on the

ear and are easily picked off and eaten. The glumes are slightly charred during this process.

If maize kernels do not have the proper moisture content, they parch rather than pop when exposed to heat. Parched maize, although not as tender as popped maize, is much easier to chew or grind than unprocessed maize, especially of the pop corn or flint type. There is little doubt that at least some of the La Perra maize was consumed in parched form.

Grinding: On many of the cobs from La Perra Cave, the glumes are battered and broken as though the ears might have been forced across a rough surface or beaten with a stick. This would indicate a crude shelling operation and this, in turn, suggests the use of shelled grain. Since stone mortars were found in La Perra Cave, it seems quite likely that, in addition to the uses described above, maize was also ground. But what use might have been made of it after grinding, there is no way of determining. There is no evidence of baking and no remains of any kind of bread. Whether the maize growers of La Perra Cave had learned to make the *tortilla*, the ubiquitous maize bread of modern Mexico, must remain an unanswered question.

Summary

1. This paper describes archaeological specimens of maize obtained from a sequence of cultural remains in La Perra Cave in Tamaulipas, Mexico.

2. The earliest maize is dated on the basis of radio carbon determinations of associated vegetal remains at 4445 ± 180 years old. The most recent maize is estimated to be 1800–2200 years old.

3. The majority of the cobs are related to the modern Mexican race Nal-Tel which today is grown principally farther south in Yucatan and Campeche. The more recent prehistoric cobs of this race are quite similar to modern Nal-Tel, but the earlier cobs are smaller, more slender and have a lower average kernel-row number. The earlier specimens also have prominent glumes and probably represent a weak form of pod corn.

4. The remaining cobs are related to the living races of maize in Mexico, Dzit-Bacal, commonly grown in Yucatan and Campeche, and Breve de Patilla, commonly grown in Tamaulipas.

5. Specimens of husks and shanks show that Early Nal-Tel had short, slender shanks and relatively long husks, lacking ligules and flag leaves, which spread open at maturity.

6. In these characteristics in which they can be directly compared, Early Nal-Tel is an accentuated form of modern Nal-Tel. On the assumption that this is also true of other characteristics, the Nal-Tel of 4500 years ago is reconstructed and described.

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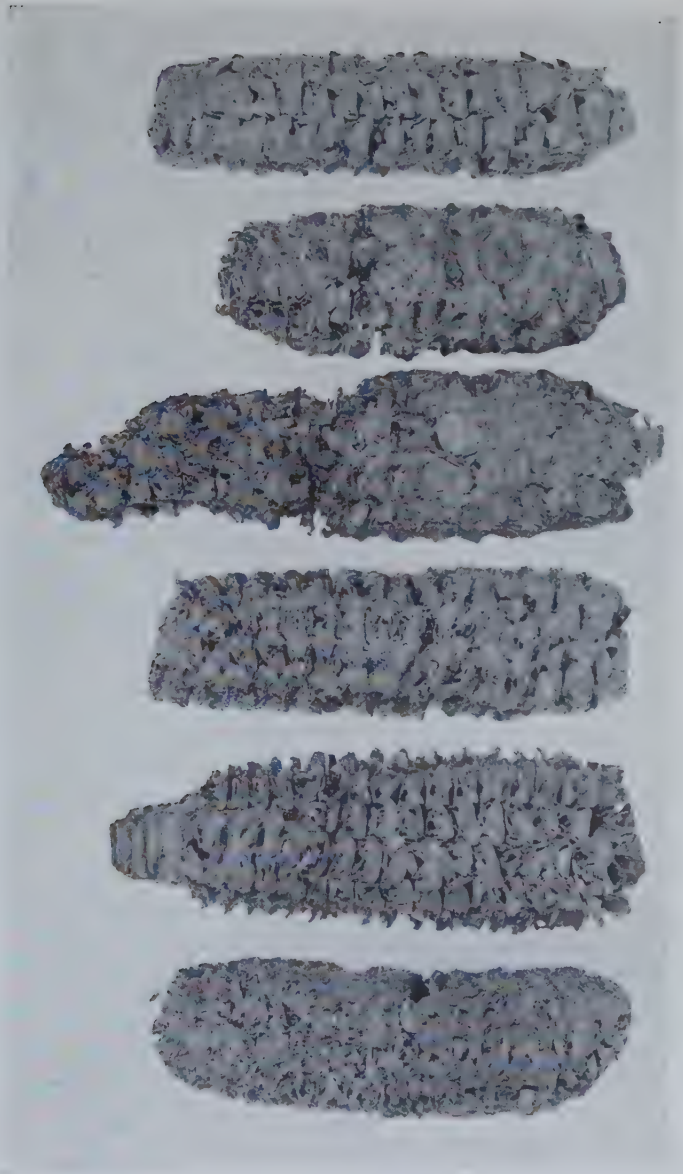
PLATE XXX. *Upper Figure.* Typical ear of modern Nal-Tel, a Mexican race of Mayan origin, today found principally in Yucatan and Campeche. Most of the maize of La Perra Cave appears to be related to this race. *Lower Figure.* Typical cobs of Early Nal-Tel, Type A. They resemble modern Nal-Tel in shape (tapering at both ends) and in internal characteristics, but are smaller and have a lower row number. Both figures natural size.

PLATE XXX

EXPLANATION OF THE ILLUSTRATION

PLATE XXXI. Typical cobs of Early Nal-Tel, Type B. These are similar to the cobs of Type A, but are slightly larger and usually ten-rowed. Natural size.

Plate XXXI



EXPLANATION OF THE ILLUSTRATION

PLATE XXXII. Typical cobs of Late Nal-Tel. These are almost identical with those of modern Nal-Tel, an ear of which is illustrated in Plate XXX. Natural size.

Plate XXXII

EXPLANATION OF THE ILLUSTRATION

PLATE XXXIII. *Left.* Two cobs resembling those of the race Dzit-Bacal, which is common in Yucatan and Campeche. *Right.* Two cobs resembling those of the race Breve de Padilla, a modern race of maize grown in the state of Tamaulipas, Mexico. Natural size.

PLATE XXXIII

EXPLANATION OF THE ILLUSTRATION

PLATE XXXIV. The rachis and cupules of an extreme form of Early Nal-Tel, showing prominent rachis flaps and hairy cupules. The phytomers are loosely joined and the cob disarticulates easily. These may be primitive characteristics. Ten times natural size.

PLATE XXXIV

EXPLANATION OF THE ILLUSTRATION

PLATE XXXV. Zapotec funerary urn from Monte Alban, Oaxaca, Mexico, the headdress adorned with moulds of ears of maize which resemble the modern race Nal-Tel. Courtesy of the National Museum, Mexico, D.F.

PLATE XXXV

EXPLANATION OF THE ILLUSTRATION

PLATE XXXVI. Funerary urn from Oaxaca, Mexico, decorated with two moulds of ears of maize which resemble in length, shape and row number the cobs of Early Nal-Tel from La Perra Cave. After Caso and Bernal, 1952.

PLATE XXXVI

EXPLANATION OF THE ILLUSTRATION

PLATE XXXVII. *Left.* A young ear-shoot of maize, partly chewed. *Center and right.* Well-chewed quids of young ears with husks attached. Apparently, one primitive use of maize was the chewing of ear-shoots and young ears for their sugar. Natural size.

Plate XXXVII